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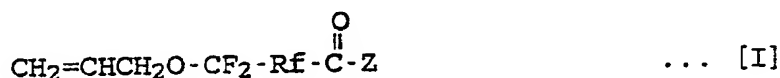
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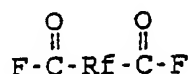
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(54) **Fluorinated carboxylic acid derivatives and methods for making.**

(57) Novel fluorinated carboxylic acid derivatives of the general formula:

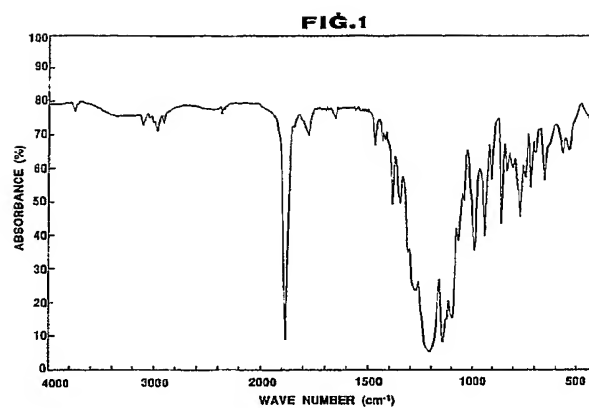


wherein Rf is a divalent perfluoroalkyl or perfluoropoly. ether group and Z is halogen, hydroxyl or triorganosiloxy are useful intermediate for the synthesis of various fluorinated compounds. Compounds [I-i] wherein Z in formula [I] is F are prepared by reacting acid fluoride-terminated compounds of the formula:



with an alkali fluoride and further with an allyl halide. Compounds [I-ii] wherein Z in formula [I] is a halogen are prepared by reacting compounds [I-i] with lithium halide. Compounds [I-iii] wherein Z in formula [I] is OH are prepared through hydrolysis of compounds [I-ii]. Compounds [I-iv] wherein Z in formula [I] is triorganosiloxy are prepared by reacting compounds [I-iii] with a triorganosilylating agent.

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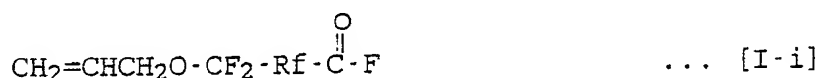
## FLUORINATED CARBOXYLIC ACID DERIVATIVES AND METHODS FOR MAKING

This invention relates to novel fluorinated carboxylic acid derivatives useful as intermediates for the synthesis of various fluorinated compounds and methods for preparing the same.

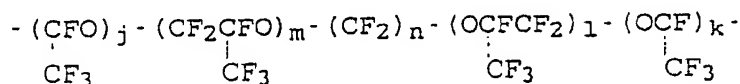
A number of fluorinated compounds are known in the art and widely used in a variety of fields of application. There is a need for an intermediate from which various fluorinated compounds can be synthesized.

Also, room temperature vulcanizable (RTV) silicone rubber compositions are known in the art. Most RTV compositions have problems of metal corrosion, poor shelf stability, discoloration, and retarded curing under acidic conditions. There is a need for RTV silicon rubber compositions which have overcome these problems and are useful as sealants, coatings and adhesives.

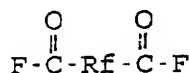
The inventors have found that a novel fluorinated carboxylic acid fluoride of the general formula:



wherein Rf is a divalent perfluoroalkyl or perfluoropoly-ether group of the general formula:



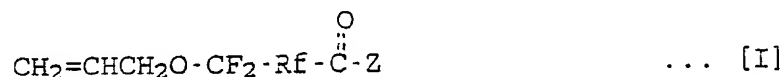
wherein n is an integer of from 0 to 8, m and 1 are integers of from 0 to 3, j and k are equal to 0 or 1, with the proviso that j=k=1=m=0 when n = 0, m = 0 when j = 0, and 1 = 0 when k = 0 is produced by reacting a compound terminated with acid fluoride at each end having the general formula:



wherein Rf is as defined above, with an alkali fluoride, and adding dropwise an allyl halide to the reaction mixture.

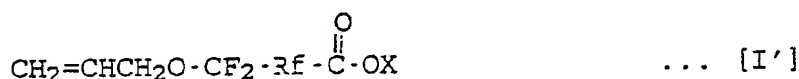
We have further found that various acid halides are obtained by reacting the acid fluorides of formula [I.i] with lithium halides, that carboxylic acids are obtained by hydrolyzing the acid fluorides of formula [I.i], and that compounds having a triorganosiloxy group attached thereto are obtained by reacting the carboxylic acids with triorganosilylating agents.

These novel fluorinated carboxylic acid derivatives are generally represented by formula [I]:



wherein Rf is as defined above, and Z is a halogen atom, hydroxyl group or triorganosiloxy group. Since they possess allyl and carboxyl groups, they are useful intermediates for the synthesis of various fluorinated compounds.

In particular, by effecting hydrosilylation between a fluorinated carboxylic acid derivative of general formula [I]:



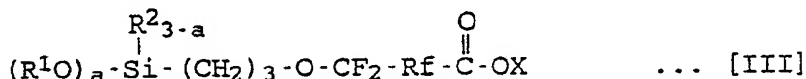
wherein Rf is as defined above and X is a hydrogen atom or triorganosiloxy group and a hydrosilane of general formula [II]:



5

wherein  $R^1$  and  $R^2$  are independently selected from substituted or unsubstituted monovalent hydrocarbon groups, and letter  $a$  is equal to 2 or 3 in the presence of an organic platinum complex catalyst, there can be synthesized a novel fluorinated carboxylic acid-containing silane of general formula [III]:

10



15

wherein  $R^1$ ,  $R^2$ ,  $Rf$ ,  $X$  and  $a$  are as defined above. This fluorinated carboxylic acid-containing silane is an effective curing catalyst for room temperature vulcanizable organopolysiloxane compositions of the condensation type, providing room temperature vulcanizable organopolysiloxane compositions which are non-corrosive to metals, shelf stable, discoloration resistant, and well curable under acidic conditions.

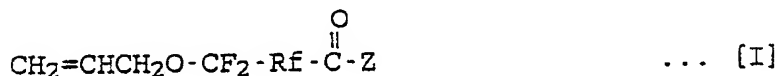
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The present invention is predicated on these findings.

FIGS. 1 to 6 are diagrams showing IR spectra of the end compounds of Examples 1 to 6, respectively.

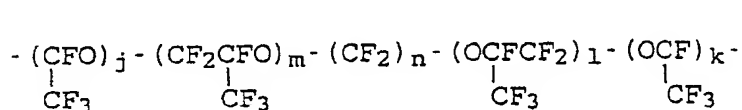
The novel fluorinated carboxylic acid derivatives of the invention are of general formula [I].

25



In formula [I],  $Rf$  is a divalent perfluoroalkyl group or divalent perfluoropolyether group of the general formula:

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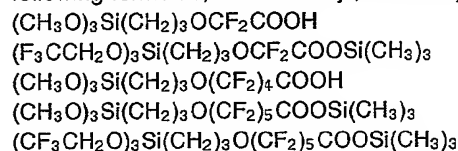
35

wherein  $n$  is an integer of from 0 to 8,  $m$  and  $1$  are integers of from 0 to 3,  $j$  and  $k$  are equal to 0 or 1, with the proviso that  $j=k=1=m=0$  when  $n=0$ ;  $m=0$  when  $j=0$ ; and  $1=0$  when  $k=0$ .

$Z$  is a halogen atom, hydroxyl group or triorganosiloxy group. The halogen atoms include fluorine, chlorine, bromine and iodine atoms, and examples of the triorganosiloxy group include trimethylsiloxy, vinyltrimethylsiloxy, ethyldimethylsiloxy, phenyldimethylsiloxy, triethylsiloxy, 3,3,3-trifluoropropyldimethylsiloxy, and 3,3,4,4,5,5,6,6,6-nonafluorohexyldimethylsiloxy groups.

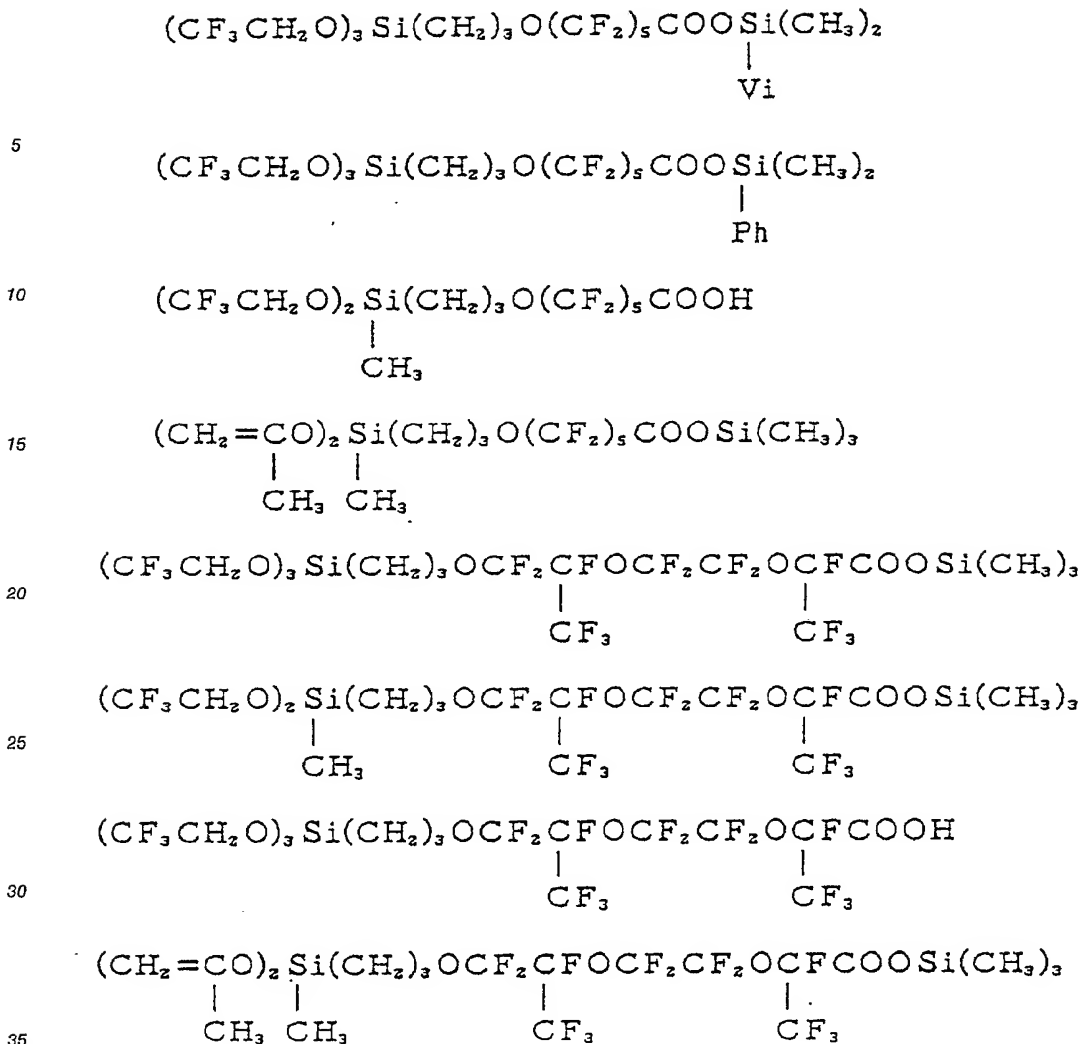
Several illustrative, non-limiting examples of the compound of formula [I] are shown below. In the following formulae, Me is methyl, Et is ethyl, Vi is vinyl, and Ph is phenyl.

45

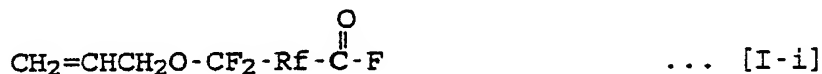


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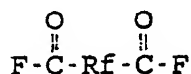
55



The novel fluorinated carboxylic acid derivatives of formula [I] are prepared by several methods. In a first method, a compound of formula [I] wherein Z is fluorine, that is, an acid fluoride of general formula [I-i]:



wherein Rf is as defined above is prepared by reacting (a) a compound terminated with acid fluoride at each end having the general formula:



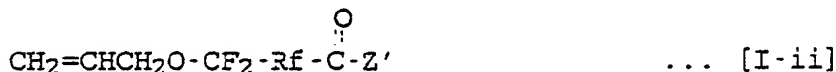
wherein Rf is as defined above, with (b) an alkali fluoride such as cesium fluoride in a polar solvent, and adding dropwise (c) an allyl halide to the reaction mixture.

In this reaction, the molar ratio (b/a) of alkali fluoride (b) to acid fluoride-terminated compound (a) is preferably 1 or higher, more preferably from 1.2 to 1.7, and the molar ratio (c/a) of allyl fluoride (c) to acid fluoride-terminated compound (a) is preferably 1 or higher, more preferably from 1.5 to 2. The reaction temperature preferably ranges from 50 to 100°C. The allyl halides used herein include allyl chloride, allyl bromide and allyl iodide. The polar solvents used herein include ether solvents such as diglyme (diethylene

glycol dimethyl ether) and tetraglyme.

The above-mentioned reaction yields a compound of formula [I] wherein Z is fluorine, that is, an acid fluoride of formula [I-i]. In a second method, by reacting this acid fluoride with a lithium halide, there is produced an acid halide of general formula [I-ii]:

5



10 wherein Rf is as defined above and Z' is a chlorine, bromine or iodine atom.

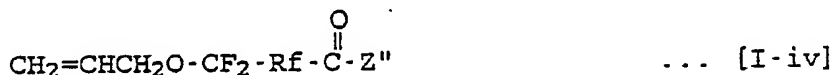
In a third method, by hydrolyzing the acid halide of formula [I-i] or [I-ii], there is produced a carboxylic acid of general formula [I-iii]:

15



wherein Rf is as defined above. In a fourth method, by reacting the carboxylic acid of formula [I.iii] with a triorganosilylating agent, there is produced a compound of general formula [I.iv]:

20



25 wherein Rf is as defined above and Z'' is a triorganosiloxy group.

Since the fluorinated carboxylic acid derivatives of formula [I] possess an allyl group and a carboxyl group per molecule, they are useful intermediates for the synthesis of various fluorinated compounds. For example, by effecting hydrosilylation between a fluorinated carboxylic acid derivative of formula [I] wherein Z is a hydroxyl or triorganosiloxy group, that is, a derivative of general formula [I']:

30



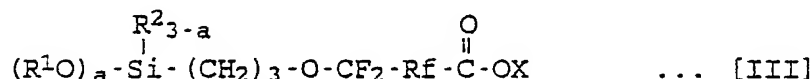
35 wherein Rf is as defined above and X is a hydrogen atom or triorganosilyl group and a hydrosilane of general formula [II]:

40



45 wherein R<sup>1</sup> and R<sup>2</sup>, which may be the same or different, are independently selected from substituted or unsubstituted monovalent hydrocarbon groups, and letter a is equal to 2 or 3 in the presence of an organic platinum complex catalyst, there can be synthesized a fluorinated carboxylic acid, containing silane of general formula [III]:

50



55 wherein R<sup>1</sup>, R<sup>2</sup>, Rf, X and a are as defined above.

The substituted or unsubstituted monovalent hydrocarbon groups represented by R<sup>1</sup> include alkyl groups such as methyl, ethyl, and propyl; alkenyl groups such as vinyl and allyl; cycloalkyl groups such as cyclopentyl and cyclohexyl; aryl groups such as phenyl and tolyl; alkenyloxy groups such as isopropenox

and isobutenoxy; and haloalkyl groups such as 2,2,2-trifluoroethoxy and 3,3,3-trifluoro-2-trifluoropropoxy. The substituted or unsubstituted monovalent hydrocarbon groups represented by R<sup>2</sup> include alkyl groups such as methyl, ethyl, and propyl; alkenyl groups such as vinyl and allyl; cycloalkyl groups such as cyclopentyl and cyclohexyl; aryl groups such as phenyl and tolyl; and haloalkyl groups such as 3,3,3-trifluoropropyl and 3,3,4,4,5,5,6,6,6-nonafluorohexyl. The triorganosilyl groups represented by X include trimethylsilyl, vinyl dimethylsilyl, triethylsilyl, trivinylsilyl, phenyldimethylsilyl, 3,3,3-trifluoropropyldimethylsilyl, and 3,3,4,4,5,5,6,6,6-nonafluorohexyldimethylsilyl groups.

In the above reaction, the molar ratio (III') of hydrosilane of formula [II] to fluorinated carboxylic acid derivative of formula [I'] is preferably 1 or higher, more preferably from 1 to 1.5. The organic platinum complex is present in a concentration of  $1 \times 10^{-3}$  to  $1 \times 10^{-6}$ %. The reaction may be carried out in a solvent which is usually benzene, toluene, xylene or hexane.

The fluorinated carboxylic acid-containing silanes of formula [III] are useful curing catalysts for room temperature vulcanizable organopolysiloxane compositions of the condensation type as will be evident from Reference Examples shown later.

There have been described fluorinated carboxylic acid derivatives of formula [I] as having alkyl and carboxyl groups. They are useful intermediates for the synthesis of various fluorinated compounds, especially fluorinated carboxylic acid-containing silanes which are useful curing catalysts for room temperature vulcanizable organopolysiloxane compositions featuring excellent curing properties, minimized thermal degradation, and least metal corrosion.

### EXAMPLE

Examples of the present invention are given below by way of illustration and not by way of limitation. Unless otherwise stated, parts and percents are by weight.

#### Example 1

A 2-liter, four-necked flask equipped with a reflux condenser and a stirrer was charged with 434 grams of cesium fluoride and 880 grams of tetraglyme. With stirring, 600 grams of perfluoroadipic fluoride was added in increments through a dropping funnel. Then 321 grams of allyl bromide was added dropwise over 30 minutes through the dropping funnel. Using an oil bath, the flask was heated to keep the contents at 70°C and stirring was continued for 24 hours at the temperature. At the end of reaction, the flask was cooled down to room temperature. After the precipitate was filtered off, the filtrate was distilled, yielding 350 grams of a fraction having a boiling point of 88.90°C/140mmHg. On analysis, this product was identified to be a compound of formula [Ia] shown below. The yield was 48%.

$$\text{CH}_2 = \text{CH}-\text{CH}_2\text{O}(\text{CF}_2)_5\text{COF} \quad [\text{Ia}]$$

#### Analysis

<sup>1</sup>H-NMR: δ (ppm)

CH <sub>2</sub> =	5.49
=CH-	6.10
-CH <sub>2</sub> O-	4.70

GC-MS:

(M+H) <sup>+</sup>	355
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IR:

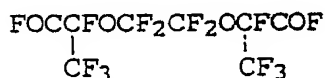
>C=O	1880 cm <sup>-1</sup>
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IR spectrum is shown in the chart of FIG. 1.

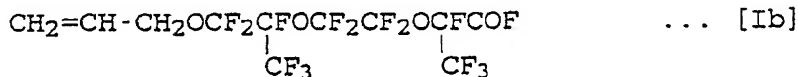
Elemental analysis:				
	C	H	O	F
Calcd. (%)	30.5	1.4	9.0	59.0
Found (%)	30.6	1.3	9.2	58.6

### Example 2

A 2-liter, four-necked flask equipped with a reflux condenser and a stirrer was charged with 500 grams of cesium fluoride and 1000 grams of tetraglyme. With stirring, 1000 grams of an acid fluoride-terminated compound of the formula:



was added in increments through a dropping funnel. Then 371 grams of allyl bromide was added dropwise over 30 minutes through the dropping funnel. Using an oil bath, the flask was heated to keep the contents at 70° C and stirring was continued for 24 hours at the temperature. At the end of reaction, the flask was cooled down to room temperature. After the precipitate was filtered off, the filtrate was distilled, yielding 503 grams of a fraction having a boiling point of 104-106° C/140mmHg. On analysis, this product was identified to be a compound of formula [Ib] shown below.



### Analysis

<sup>1</sup>H-NMR: δ (ppm)

CH<sub>2</sub>= 5.47

=CH- 6.08

-CH<sub>2</sub>-O- 4.69

GC-MS:

(M+H)<sup>+</sup> 487

IR:

>C=O 1880 cm<sup>-1</sup>

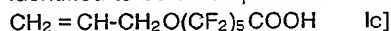
IR spectrum is shown in the chart of FIG. 2.



Elemental analysis:				
	C	H	O	F
Calcd. (%)	27.2	1.0	13.2	58.6
Found (%)	27.1	1.1	13.0	58.3

### Example 3

A 500-ml, four-necked flask equipped with a reflux condenser and a stirrer was charged with 62 grams of water and 36 grams of sodium fluoride. Using an ice water bath, the flask was cooled until the contents reached 10° C. With stirring, 300 grams of the compound of formula [Ia] obtained in Example 1 was added dropwise through a dropping funnel. The rate of addition was controlled such that the contents did not exceed 20° C. After the completion of addition, the ice water bath was removed and stirring was continued for 3 hours. The solids were removed from the flask contents by filtration, and the filtrate was then distilled, yielding 265 grams of a fraction having a boiling point of 93-99° C/2mmHg. On analysis, this product was identified to be a compound of formula [Ic] shown below. The yield was 88%.



### Analysis

<sup>1</sup>H-NMR: δ (ppm)

CH<sub>2</sub>= 5.45

=CH- 6.08

-CH<sub>2</sub>-O- 4.63

-COOH 11.4

GC-MS:

(M+H)<sup>+</sup> 353

IR:

>C=O 1780 cm<sup>-1</sup>

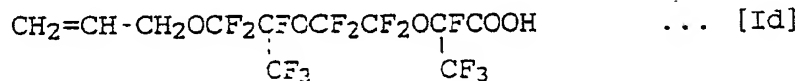
IR spectrum is shown in the chart of FIG. 3.

Elemental analysis:				
	C	H	O	F
Calcd. (%)	30.7	1.7	13.6	54.0
Found (%)	30.8	1.6	13.3	54.1

### Example 4

A 500-ml, four-necked flask equipped with a reflux condenser and a stirrer was charged with 45 grams of water and 26 grams of sodium fluoride. Using an ice water bath, the flask was cooled until the contents reached 10° C. With stirring, 300 grams of the compound of formula [Ib] obtained in Example 2 was added dropwise through a dropping funnel. The rate of addition was controlled such that the contents did not exceed 20° C. After the completion of addition, the ice water bath was removed and stirring was continued

for 3 hours at room temperature. The solids were removed from the flask contents by filtration, and the filtrate was then distilled, yielding 268 grams of a fraction having a boiling point of 108-110° C/3mmHg. On analysis, this product was identified to be a compound of formula [Id] shown below. The yield was 90%.



### Analysis

<sup>1</sup>H-NMR: δ (ppm)

CH <sub>2</sub> =	5.43
=CH-	6.04
-CH <sub>2</sub> -O-	4.66
-COOH	11.5

GC-MS:

(M+H)<sup>+</sup> 485

IR:

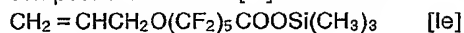
>C=O 1780 cm<sup>-1</sup>

IR spectrum is shown in the chart of FIG. 4.

Elemental analysis:				
	C	H	O	F
Calcd. (%)	27.3	1.2	16.5	54.9
Found (%)	27.1	1.3	16.8	54.5

### Example 5

A 500-ml, four-necked flask equipped with a reflux condenser and a stirrer was charged with 48 grams of bistrimethylsilylacetamide and 100 grams of toluene. With stirring, 150 grams of the compound of formula [Ic] obtained in Example 3 was added dropwise through a dropping funnel. The rate of addition was controlled such that the contents did not exceed 50° C. After the completion of addition, stirring was continued for 2 hours at room temperature. The flask contents were then distilled, yielding 156 grams of a fraction having a boiling point of 93.0-93.5° C/6mmHg. On analysis, this product was identified to be a compound of formula [Ie] shown below. The yield was 86%.



### Analysis

<sup>1</sup>H-NMR: δ (ppm)

CH <sub>2</sub> =	5.39
=CH-	6.03

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-CH<sub>2</sub>-O- 4.66

-Si(CH<sub>3</sub>)<sub>3</sub> 0.50

GC-MS:

(M+H)<sup>+</sup> 425

IR:

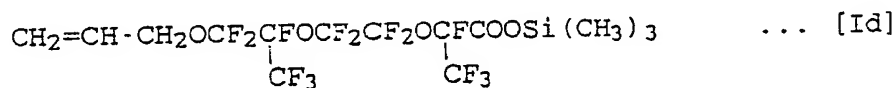
>C=O 1770 cm<sup>-1</sup>

IR spectrum is shown in the chart of FIG. 5.

Elemental analysis:					
	C	H	O	F	Si
Calcd. (%)	34.0	3.3	11.3	44.8	6.6
Found (%)	34.2	3.2	11.3	44.7	6.5

Example 6

A 500-ml, four-necked flask equipped with a reflux condenser and a stirrer was charged with 47 grams of bistrimethylsilylaceta-  
 midide and 134 grams of toluene. With stirring, 200 grams of the compound of  
 formula [Id] obtained in Example 4 was added dropwise through a dropping funnel. The rate of addition was  
 controlled such that the contents did not exceed 50° C. After the completion of addition, stirring was  
 continued for 2 hours at room temperature. The flask contents were then distilled, yielding 197 grams of a  
 fraction having a boiling point of 97-99° C/6mmHg. On analysis, this product was identified to be a  
 compound of formula [If] shown below. The yield was 85%.



Analysis

<sup>1</sup>H-NMR: δ (ppm)

CH<sub>2</sub>= 5.45

=CH- 6.07

-CH<sub>2</sub>-O- 4.71

-Si(CH<sub>3</sub>)<sub>3</sub> 0.51

GC-MS:

(M+H)<sup>+</sup> 557

IR:

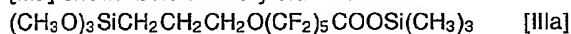
>C=O 1770 cm<sup>-1</sup>

IR spectrum is shown in the chart of FIG. 6.

Elemental analysis:					
	C	H	O	F	Si
Calcd. (%)	30.2	2.5	14.4	47.8	5.0
Found (%)	30.0	2.7	14.6	47.8	4.7

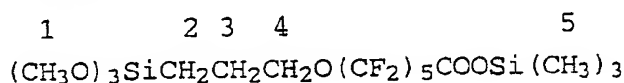
#### Reference Example 1

A 200-ml, three-necked flask equipped with a reflux condenser, magnetic stirrer, and thermometer was charged with 70.0 grams of the compound of formula [Ie] obtained in Example 5. Using an oil bath, the flask was heated to keep the contents at 70 °C. After 0.01 gram of a 10% toluene solution of chloroplatinic acid was added, 24.2 grams of trimethoxysilane was slowly added through a dropping funnel. The rate of addition was controlled such that the contents were at 70 to 100 °C. After the completion of addition, stirring was continued for one hour at 70 °C. At the end of reaction, the flask contents were poured into a distillation flask. The flask was heated by an oil bath adjusted at 80 °C while the flask interior was evacuated up to 2 mmHg by means of a vacuum pump. The volatile contents were distilled off in this way, leaving 85.2 grams of a non-volatile liquid in the flask. On analysis, this product was identified to be a compound of formula [IIIa] shown below. The yield was 95%.



#### Analysis

$^1\text{H}$ -NMR:



$\delta$  (ppm)

1	3.51
2	1.01
3	1.91
4	4.17
5	0.51

GC-MS:

$(\text{M}+\text{H})^+$  546

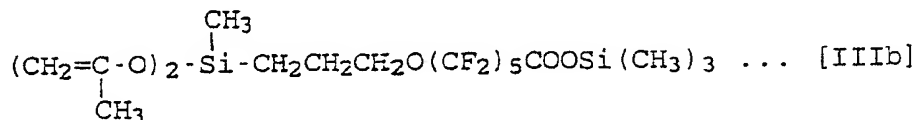
IR:

$>\text{C}=\text{O}$  1770  $\text{cm}^{-1}$

#### Reference Example 2

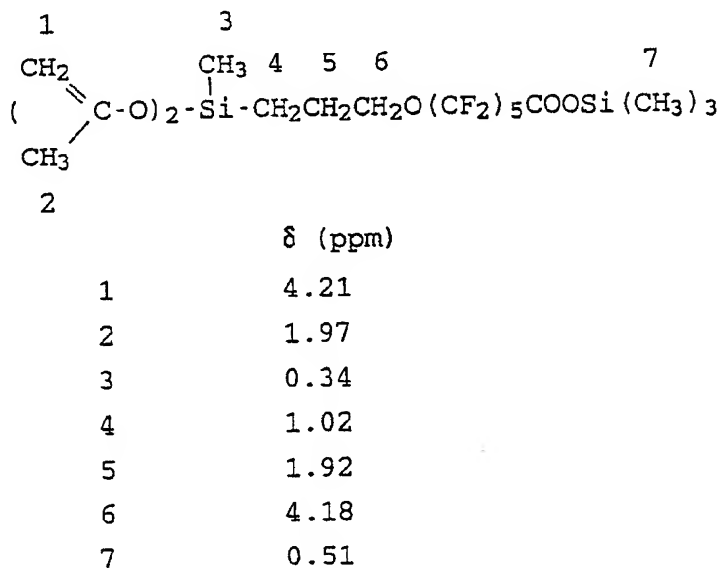
A 200-ml, three-necked flask equipped with a reflux condenser, magnetic stirrer, and thermometer was

charged with 70 grams of the compound of formula [Ie] obtained in Example 5. Using an oil bath, the flask was heated to keep the contents at 70 °C. After 0.01 gram of a 10% toluene solution of chloroplatinic acid was added, 31.3 grams of diisopropenoxymethylsilane was slowly added through a dropping funnel. The rate of addition was controlled such that the contents were at 70 to 100 °C. After the completion of addition, stirring was continued for one hour at 70 °C. At the end of reaction, the flask contents were poured into a distillation flask. The flask was heated by an oil bath adjusted at 80 °C while the flask interior was evacuated up to 2 mmHg by means of a vacuum pump. The volatile contents were distilled off in this way, leaving 89.5 grams of a non-volatile liquid in the flask. On analysis, this product was identified to be a compound of formula [IIIb] shown below. The yield was 93%.



### Analysis

<sup>1</sup>H-NMR:



GC-MS:

(M+H)<sup>+</sup> 583

IR:

>C=O 1770 cm<sup>-1</sup>

### Elemental analysis:

	C	H	O	F	Si
Calcd. (%)	39.2	4.8	13.7	32.6	9.6
Found (%)	39.1	4.9	13.7	32.4	9.7

Reference Example 3

A 200-ml, three-necked flask equipped with a reflux condenser, magnetic stirrer, and thermometer was charged with 70 grams of the compound of formula [Ie] obtained in Example 5. Using an oil bath, the flask was heated to keep the contents at 70 °C. After 0.01 gram of a 10% toluene solution of chloroplatinic acid was added, 64.5 grams of tris(2,2,2-trifluoroethoxy)silane was slowly added through a dropping funnel. The rate of addition was controlled such that the contents were at 70 to 100 °C. After the completion of addition, stirring was continued for one hour at 70 °C. At the end of reaction, the flask contents were poured into a distillation flask. The flask was heated by an oil bath adjusted at 80 °C while the flask interior was evacuated up to 2 mmHg by means of a vacuum pump. The volatile contents were distilled off in this way, leaving 120.3 grams of a non-volatile liquid in the flask. On analysis, this product was identified to be a compound of formula [IIIc] shown below. The yield was 97%.  
 $(\text{CF}_3\text{CH}_2\text{O})_3\text{SiCH}_2\text{CH}_2\text{CH}_2\text{O}(\text{CF}_2)_5\text{COOSi}(\text{CH}_3)_3$  [IIIc]

Analysis<sup>1</sup>H-NMR:

	1	2	3	4	5
	$(\text{CF}_3\text{CH}_2\text{O})_3\text{SiCH}_2\text{CH}_2\text{CH}_2\text{O}(\text{CF}_2)_5\text{COOSi}(\text{CH}_3)_3$				
	$\delta$ (ppm)				
	1			4.17	
	2			4.17	
	3			1.91	
	4			1.01	
	5			0.51	

GC-MS:

 $(\text{M}+\text{H})^+$  751

IR:

>C=O 1770  $\text{cm}^{-1}$ 

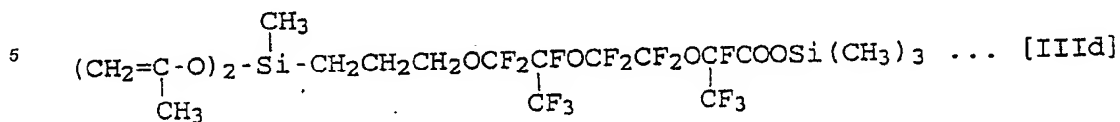
## Elemental analysis:

	C	H	O	F	Si
Calcd. (%)	28.8	2.8	12.8	48.1	7.5
Found (%)	29.0	2.6	12.9	48.3	7.2

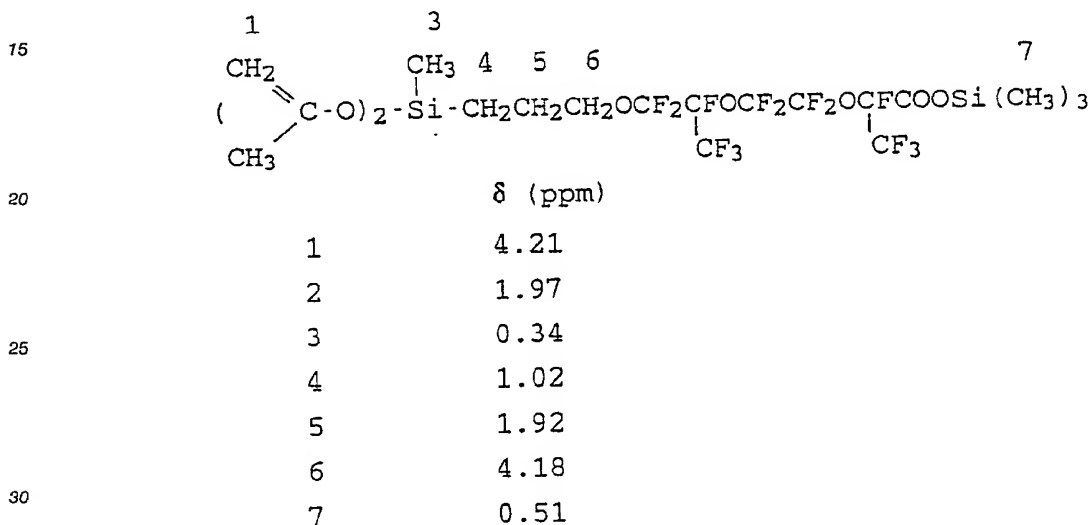
Reference Example 4

A 200-ml, three-necked flask equipped with a reflux condenser, magnetic stirrer, and thermometer was charged with 80 grams of the compound of formula [If] obtained in Example 6. Using an oil bath, the flask was heated to keep the contents at 70 °C. After 0.01 gram of a 10% toluene solution of chloroplatinic acid was added, 27.3 grams of diisopropenoxynethylsilane was slowly added through a dropping funnel. The rate of addition was controlled such that the contents were at 70 to 100 °C. After the completion of addition, stirring was continued for one hour at 70 °C. At the end of reaction, stirring was continued for further one hour at 70 °C. Then the flask contents were poured into a distillation flask. The flask was heated by an oil bath adjusted at 80 °C while the flask interior was evacuated up to 2 mmHg by means of a vacuum pump.

The volatile contents were distilled off in this way, leaving 91.0 grams of a non-volatile liquid in the flask. On analysis, this product was identified to be a compound of formula [III<sub>d</sub>] shown below. The yield was 88%.



## Analysis

 $^1\text{H}$ -NMR:

GC - MS :

(M+H)<sup>+</sup> 715

IR:

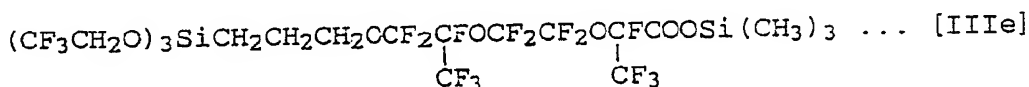
$$>C=O \quad 1770 \text{ cm}^{-1}$$

Elemental analysis:					
	C	H	O	F	Si
Calcd. (%)	35.3	3.9	15.7	37.3	7.8
Found (%)	35.7	3.6	15.3	37.8	7.6

<sup>50</sup> Reference Example 5

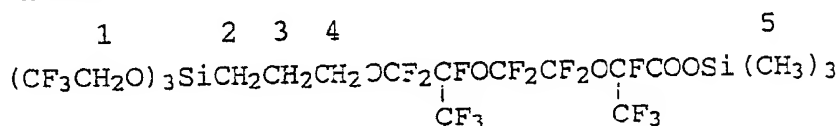
A 200-ml, three-necked flask equipped with a reflux condenser, magnetic stirrer, and thermometer was charged with 80 grams of the compound of formula [If] obtained in Example 6. Using an oil bath, the flask was heated to keep the contents at 70 °C. After 0.01 gram of a 10% toluene solution of chloroplatinic acid was added, 56.3 grams of tris(2,2,2-trifluoroethoxy)silane was slowly added through a dropping funnel. The rate of addition was controlled such that the contents were at 70 to 100 °C. After the completion of addition, stirring was continued for one hour at 70 °C. At the end of reaction, stirring was continued for further one hour at 70 °C. Then the flask contents were poured into a distillation flask. The flask was heated by an oil

bath adjusted at 80 °C while the flask interior was evacuated up to 2 mmHg by means of a vacuum pump. The volatile contents were distilled off in this way, leaving 118.2 grams of a non-volatile liquid in the flask. On analysis, this product was identified to be a compound of formula [IIIe] shown below. The yield was 93%.



### Analysis

<sup>1</sup>H-NMR:



δ (ppm)

1	4.17
2	4.17
3	1.91
4	1.01
5	0.51

GC-MS:

(M+H)<sup>+</sup> 883

IR:

>C=O 1770 cm<sup>-1</sup>

### Elemental analysis:

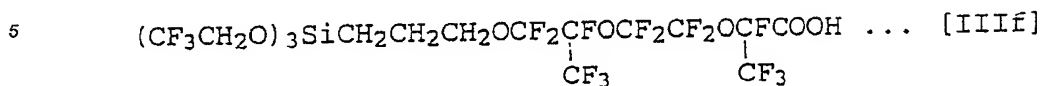
	C	H	O	F	Si
Calcd. (%)	27.2	2.4	14.5	49.5	6.4
Found (%)	27.1	2.3	14.7	49.3	6.5

### Reference Example 6

A 100-ml, three-necked flask equipped with a reflux condenser, magnetic stirrer, and thermometer was charged with 50 grams of the compound of formula [IIIe] obtained in Reference Example 5. With stirring, the flask was cooled with an ice water bath until the flask contents reached 5 °C. After 1.02 grams of water was added dropwise through a dropping funnel, stirring was continued for one hour while maintaining ice water cooling. Thereafter, the flask was heated by an oil bath adjusted at 50 °C while the flask interior was evacuated up to 2 mmHg by means of a vacuum pump. The volatile contents were distilled off in this way,



leaving 44.7 grams of a non-volatile liquid in the flask. On analysis, this product was identified to be a compound of formula [III<sub>f</sub>] shown below.



10

### Analysis

<sup>1</sup>H-NMR:

15	1	2	3	4	5
	$(\text{CF}_3\text{CH}_2\text{O})_3\text{SiCH}_2\text{CH}_2\text{CH}_2\text{OCF}_2\underset{\text{CF}_3}{\text{C}}\text{FOCF}_2\text{CF}_2\underset{\text{CF}_3}{\text{C}}\text{OFCOOH}$				
	$\delta$ (ppm)				
20	1			4.17	
	2			4.17	
	3			1.91	
25	4			1.01	
	5			11.5	

GC-MS:

30	(M+H) <sup>+</sup>	811
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IR:

	>C=O	1780 cm <sup>-1</sup>
35	-OH	3200 cm <sup>-1</sup>

40

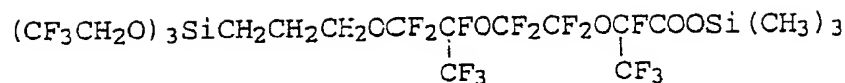
Elemental analysis:					
	C	H	O	F	Si
Calcd. (%)	25.2	1.6	15.8	54.0	3.4
Found (%)	24.8	1.7	15.3	54.5	3.6

45

### Reference Example 7

50 Composition I was prepared by blending 100 parts of a dimethylpolysiloxane blocked with a hydroxyl group at each end of its molecular chain having a viscosity of 20,200 centipoise at 25° C, 12 parts of fumed silica surface treated with hexamethyldisilazane having a specific surface area of 150 m<sup>2</sup>/g, and 1.5 parts of titanium dioxide, and passing the blend through a three-roll mill once. The blend was further mixed with 6 parts of methyltriisopropenoxysilane and 0.5 parts of the perfluorocarboxylic derivative of the formula:

55



obtained in Reference Example 5 in an anhydrous condition while defoaming.

Composition I was formed into a sheet of 2 mm thick and allowed to stand for 7 days in an atmosphere at a temperature of 20 °C and a relative humidity of 55%. This caused the sheet to cure into a rubbery elastomer Ia.

Composition I remained stable over 6 months at room temperature if sealed against the ambient. This 6-month aged composition I was also formed into a sheet of 2 mm thick which was cured under the same conditions as above into a rubbery elastomer Ib. The elastomers obtained from the fresh and aged compositions were examined for physical properties (hardness, tensile strength and elongation) according to JIS C-2123.

Further, rubbery elastomer Ia was exposed to 200 °C for 7 days for thermal degradation. This thermally degraded rubbery elastomer Ic was similarly examined for physical properties.

The results are shown in Table 1.

Table 1

	Initial	Aged @ 20 °C/6 month	Heated @ 200 °C/7 days
	Elastomer Ia	Elastomer Ib	Elastomer Ic
Hardness, JIS-A	29	31	33
Tensile strength, kg/cm <sup>2</sup>	20	19	21
Elongation, %	350	330	270

In addition, Composition I was tested by the metal corrosion test as prescribed in MIL-A-46146A.

#### Test method 1

Composition I, 15 grams, was placed in a 250 ml container. Onto Composition I was poured 5 to 10 ml of distilled water. A clean test piece was suspended above the water surface. The container was sealed at the top. The container was allowed to stand for 168 hours at 38 °C. The test piece was visually observed for corrosion.

#### Test method 2

A test piece was cleaned with acetone and coated with Composition I, which was cured for 7 days at 25 °C and RH 50%. The test piece was then allowed to stand for 28 days at 49 °C and RH 98%. The rubbery elastomer coating was stripped using a knife. The surface of the test piece from which the coating was stripped was visually observed for corrosion.

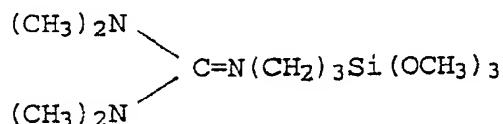
The results are shown in Table 2.

Table 2

	Test piece	Result
Test method 1	Brass	no corrosion
	Steel	no corrosion
	Aluminum	no corrosion
Test method 2	Copper wire	no corrosion
	Steel	no corrosion
	Aluminum	no corrosion

Rubbery elastomer Ia resulting from curing of Composition I was measured for a change of color at the initial, after heating at 90° C for 168 hours, and after weatherometer exposure for 168 hours, using a differential colorimeter.

For comparison purposes, Composition II was prepared which had the same formulation as Composition I except that 0.5 parts of a guanidine derivative of the formula:



was used instead of the perfluorocarboxylic derivative. A cured sheet of 2 mm thick was formed from Composition II by the same procedure as described for Composition I and subjected to a discoloration test.

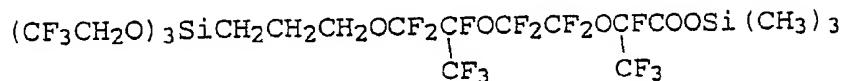
The results are shown in Table 3.

Table 3

	Composition I				Composition II			
	<u>L</u>	<u>a</u>	<u>b</u>	<u>ΔE</u>	<u>L</u>	<u>a</u>	<u>b</u>	<u>ΔE</u>
Initial	94.2	-0.3	1.9	-	92.6	-0.9	2.5	-
90° C/168hr.	93.6	-1.8	7.7	6.0	88.2	-3.6	18.2	16.5
Weathering	94.0	-0.7	3.6	1.7	90.6	-2.8	12.2	10.1
Discoloration $\Delta E = [(\Delta L)^2 + (\Delta a)^2 + (\Delta b)^2]^{1/2}$								

#### Reference Example 8

Composition III was prepared by blending 100 parts of 3,3,3-trifluoropropylmethylpolysiloxane blocked with a hydroxyl group at each end of its molecular chain having a viscosity of 62,300 centipoise at 25° C and 8 parts of fumed silica surface treated with dimethyldichlorosilane having a specific surface area of 180 m<sup>2</sup>/g and passing the blend through a three-roll mill once. The blend was further mixed with 6 parts of vinyltriisopropenoxysilane, 0.4 parts of the perfluorocarboxylic derivative of the formula:



obtained in Reference Example 5, and 0.1 part of dibutyltin dioctoate in an anhydrous condition while defoaming.

Composition III was formed into a sheet of 2 mm thick and allowed to stand for 7 days in an atmosphere at a temperature of 20 °C and a relative humidity of 55%. This caused the sheet to cure into a rubbery elastomer IIIa.

Composition III remained stable over 6 months at room temperature if sealed against the ambient. This 6-month aged composition III was also formed into a sheet of 2 mm thick which was cured under the same conditions as above into a rubbery elastomer IIIb. The elastomers obtained from the fresh and aged compositions were examined for physical properties (hardness, tensile strength and elongation) according to JIS C-2123.

Further, rubbery elastomer IIIa was exposed to 200 °C for 7 days for thermal degradation. This thermally degraded rubbery elastomer IIIc was similarly examined for physical properties.

The results are shown in Table 4.

Table 4

	Initial	Aged @ 20 °C/6 month	Heated @ 200 °C/7 days
Elastomer	IIIa	IIIb	IIIc
Hardness, JIS-A	27	28	33
Tensile strength, kg/cm <sup>2</sup>	25	23	17
Elongation, %	280	260	200

In addition, Composition III was tested for metal corrosion as previously described. The results are shown in Table 5.

Table 5

	Test piece	Result
Test method 1	Brass Steel Aluminum	no corrosion no corrosion no corrosion
Test method 2	Copper wire Steel Aluminum	no corrosion no corrosion no corrosion

#### Reference Example 9

Composition IV was prepared by blending 100 parts of a dimethylpolysiloxane blocked with a hydroxyl group at each end of its molecular chain having a viscosity of 10,500 centipoise at 25 °C and 10 parts of carbon powder and passing the blend through a three-roll mill once. The blend was further mixed with 7 parts of phenyltriisopropenoxysilane and 0.4 parts of the perfluorocarboxylic derivative of the formula:  $(\text{CH}_3\text{O})_3\text{SiCH}_2\text{CH}_2\text{CH}_2\text{O}(\text{CF}_2)_5\text{COOSi}(\text{CH}_3)_3$  obtained in Reference Example 1 in an anhydrous condition while defoaming.

Composition IV was formed into a sheet of 2 mm thick and allowed to stand for 7 days in an atmosphere at a temperature of 20 °C and a relative humidity of 55%. This caused the sheet to cure into a rubbery elastomer IVa.

Composition IV remained stable over 6 months at room temperature if sealed against the ambient. This 6-month aged composition IV was also formed into a sheet of 2 mm thick which was cured under the same conditions as above into a rubbery elastomer IVb. The elastomers obtained from the fresh and aged

compositions were examined for physical properties (hardness, tensile strength and elongation) according to JIS C-2123.

The results are shown in Table 6.

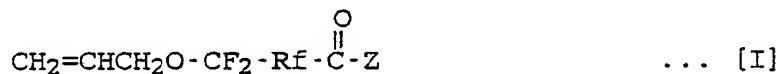
Table 6

	Initial	Aged @ 20 ° C/6 month
	Elastomer IVa	Elastomer IVb
Hardness, JIS-A	25	26
Tensile strength, kg/cm <sup>2</sup>	17	18
Elongation, %	250	230

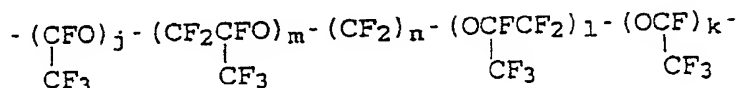
Although some preferred embodiments have been described, many modifications and variations may be made thereto in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described.

### Claims

1. A fluorinated carboxylic acid derivative of the general formula:

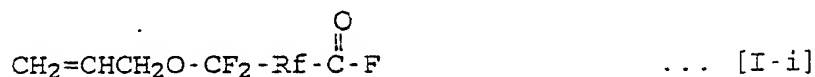


wherein Rf is a divalent perfluoroalkyl or perfluoropolyether group of the general formula:

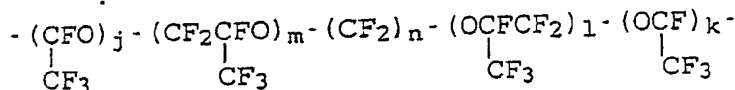


wherein n is an integer of from 0 to 8, m and 1 are integers of from 0 to 3, j and k are equal to 0 or 1, with the proviso that j=k=l=m=0 when n = 0, m = 0 when j = 0, and l = 0 when k = 0, and Z is a halogen atom, hydroxyl group or triorganosiloxy group.

2. A method for preparing a fluorinated carboxylic acid derivative of the general formula:

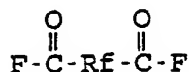


wherein Rf is a divalent perfluoroalkyl or perfluoropolyether group of the general formula:



wherein n is an integer of from 0 to 8, m and l are integers of from 0 to 3, j and k are equal to 0 or 1, with the proviso that j=k=l=m=0 when n = 0, m = 0 when j = 0, and l = 0 when k = 0, said method comprising the steps of:

reacting a compound terminated with acid fluoride at each end having the general formula:

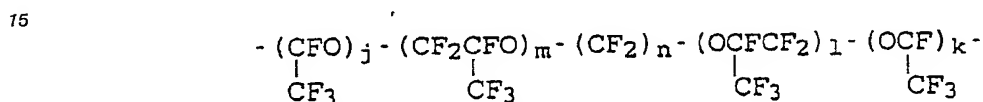


5 wherein Rf is as defined above, with an alkali fluoride, and reacting the reaction product with an allyl halide.

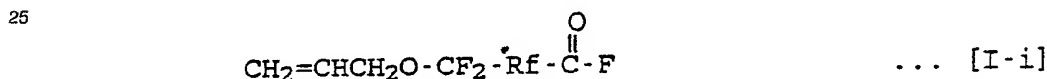
3. A method for preparing a fluorinated carboxylic acid derivative of the general formula:



wherein Rf is a divalent perfluoroalkyl or perfluoropolyether group of the general formula:

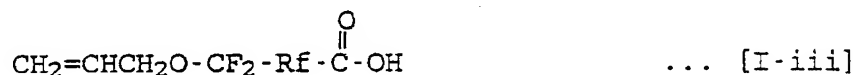


20 wherein n is an integer of from 0 to 8, m and l are integers of from 0 to 3, j and k are equal to 0 or 1, with the proviso that j=k=l=m=0 when n = 0, m = 0 when j = 0, and l = 0 when k = 0, and Z' is a chlorine, bromine or iodine atom, said method comprising the step of:  
reacting a compound of the general formula:

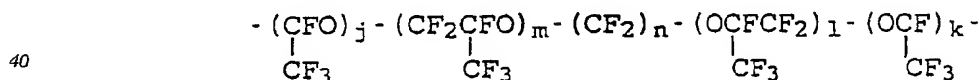


wherein Rf is as defined above with a lithium halide.

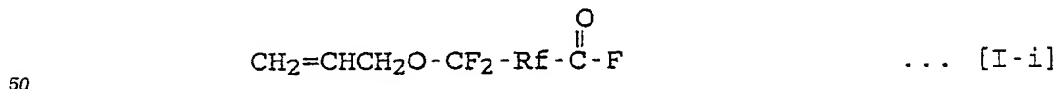
30 4. A method for preparing a fluorinated carboxylic acid derivative of the general formula:



35 wherein Rf is a divalent perfluoroalkyl or perfluoropolyether group of the general formula:

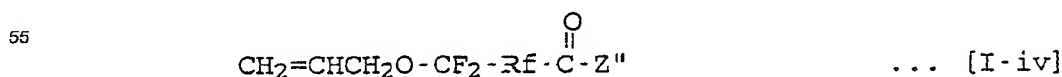


45 wherein n is an integer of from 0 to 8, m and l are integers of from 0 to 3, j and k are equal to 0 or 1, with the proviso that j=k=l=m=0 when n = 0, m = 0 when j = 0, and l = 0 when k = 0, said method comprising the step of:  
hydrolyzing a compound of the general formula:

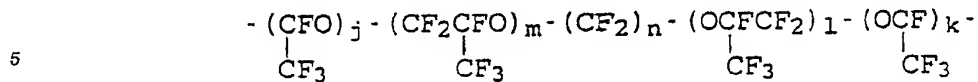


wherein Rf is as defined above.

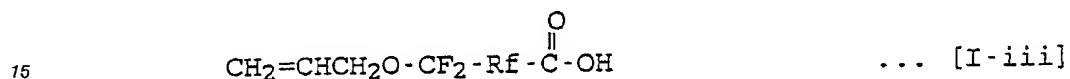
5. A method for preparing a fluorinated carboxylic acid derivative of the general formula:



wherein Rf is a divalent perfluoroalkyl or perfluoropolyether group of the general formula:



10 wherein n is an integer of from 0 to 8, m and l are integers of from 0 to 3, j and k are equal to 0 or 1, with the proviso that j=k=l=m=0 when n = 0, m = 0 when j = 0, and l = 0 when k = 0, and Z'' is a triorganosiloxy group, said method comprising the step of:  
reacting a compound of the general formula:



wherein Rf is as defined above with a triorganosilylating agent.

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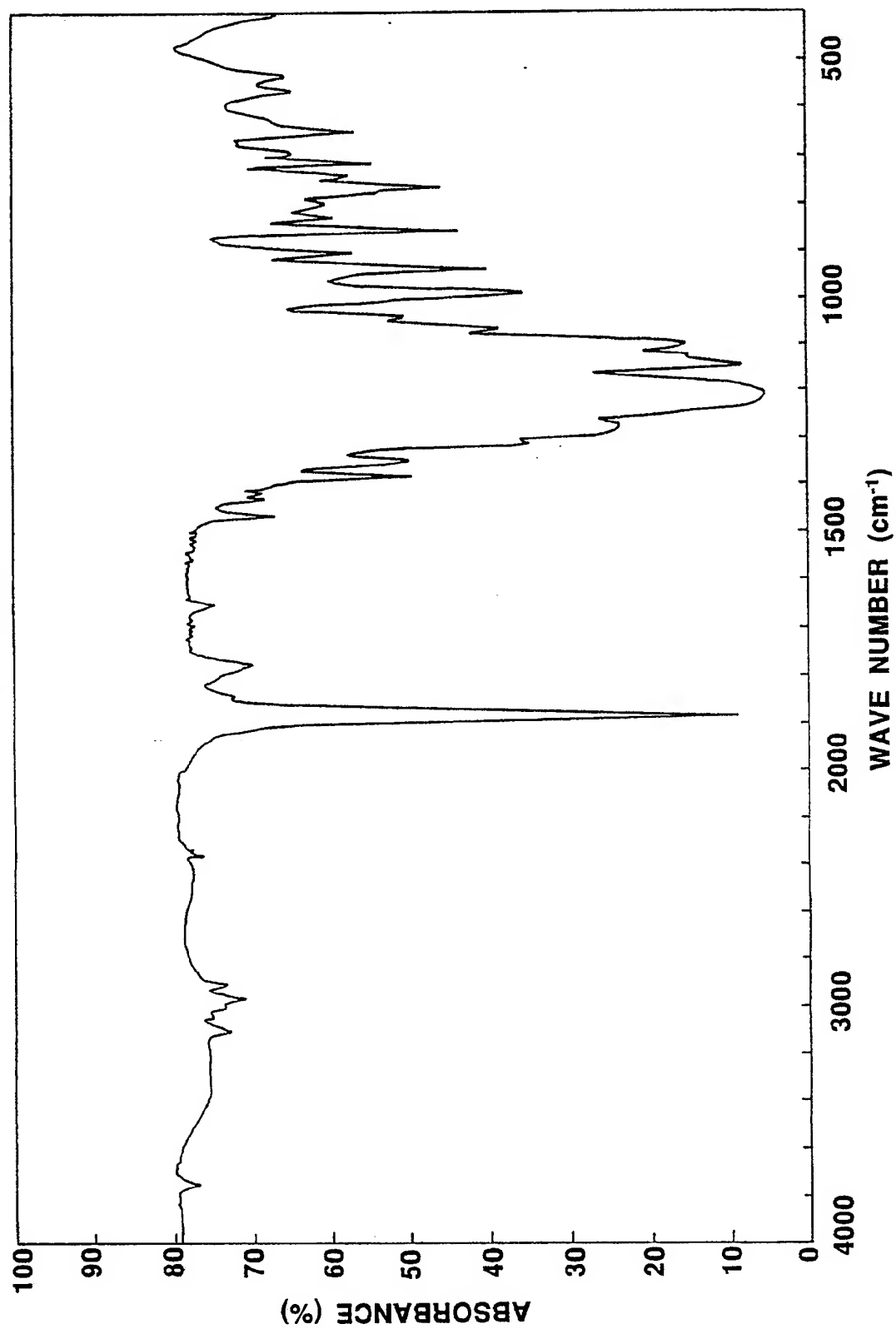
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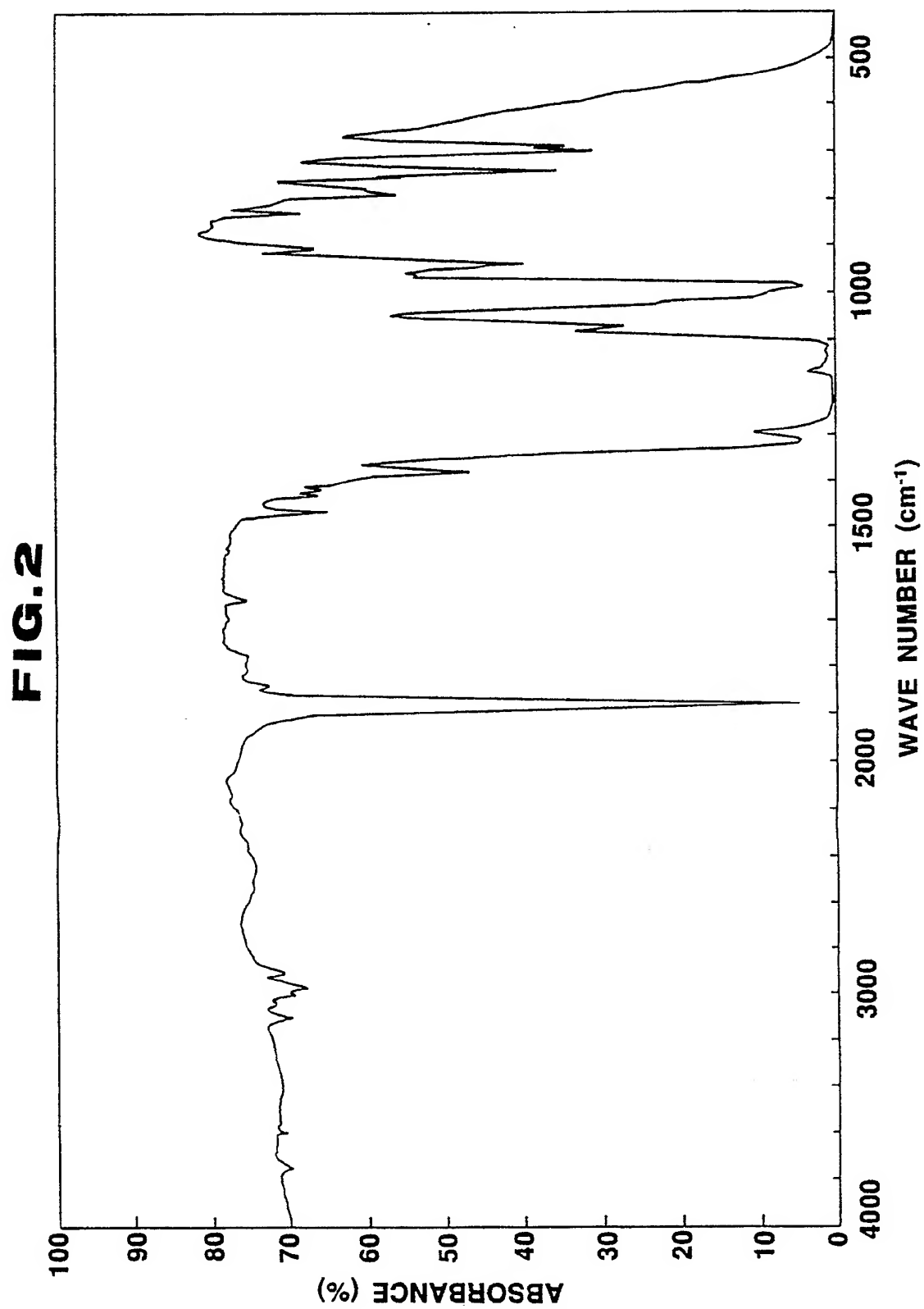
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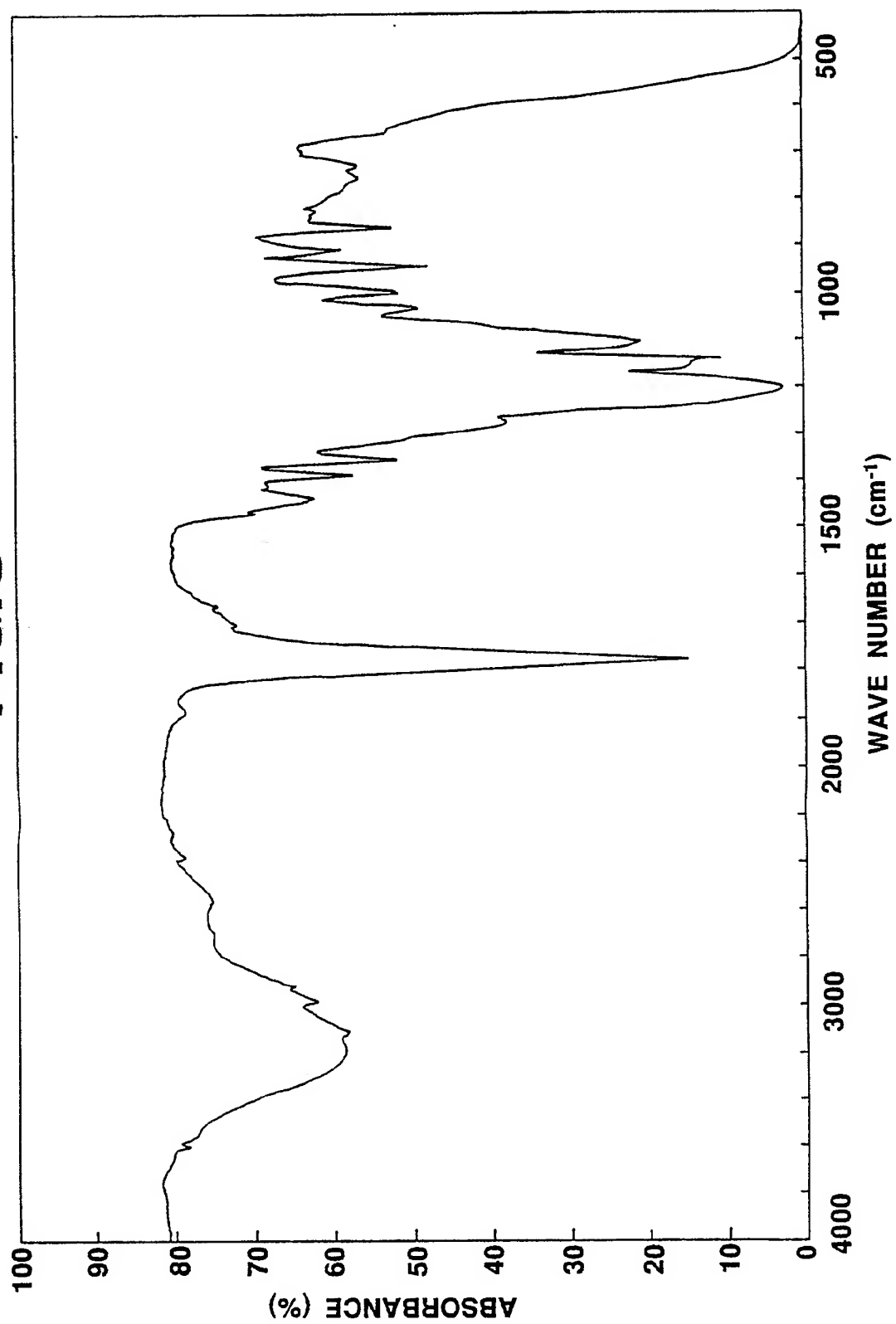
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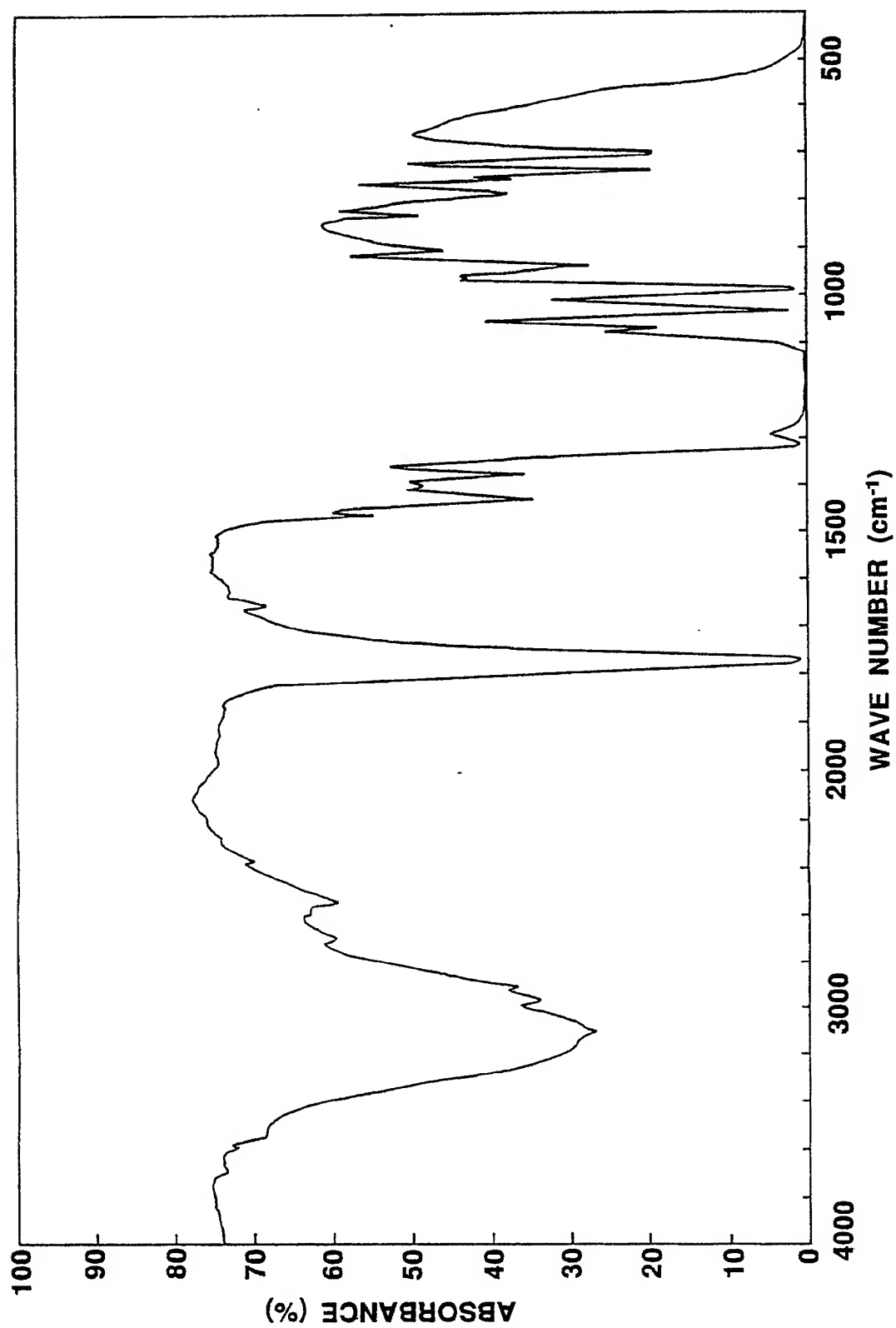
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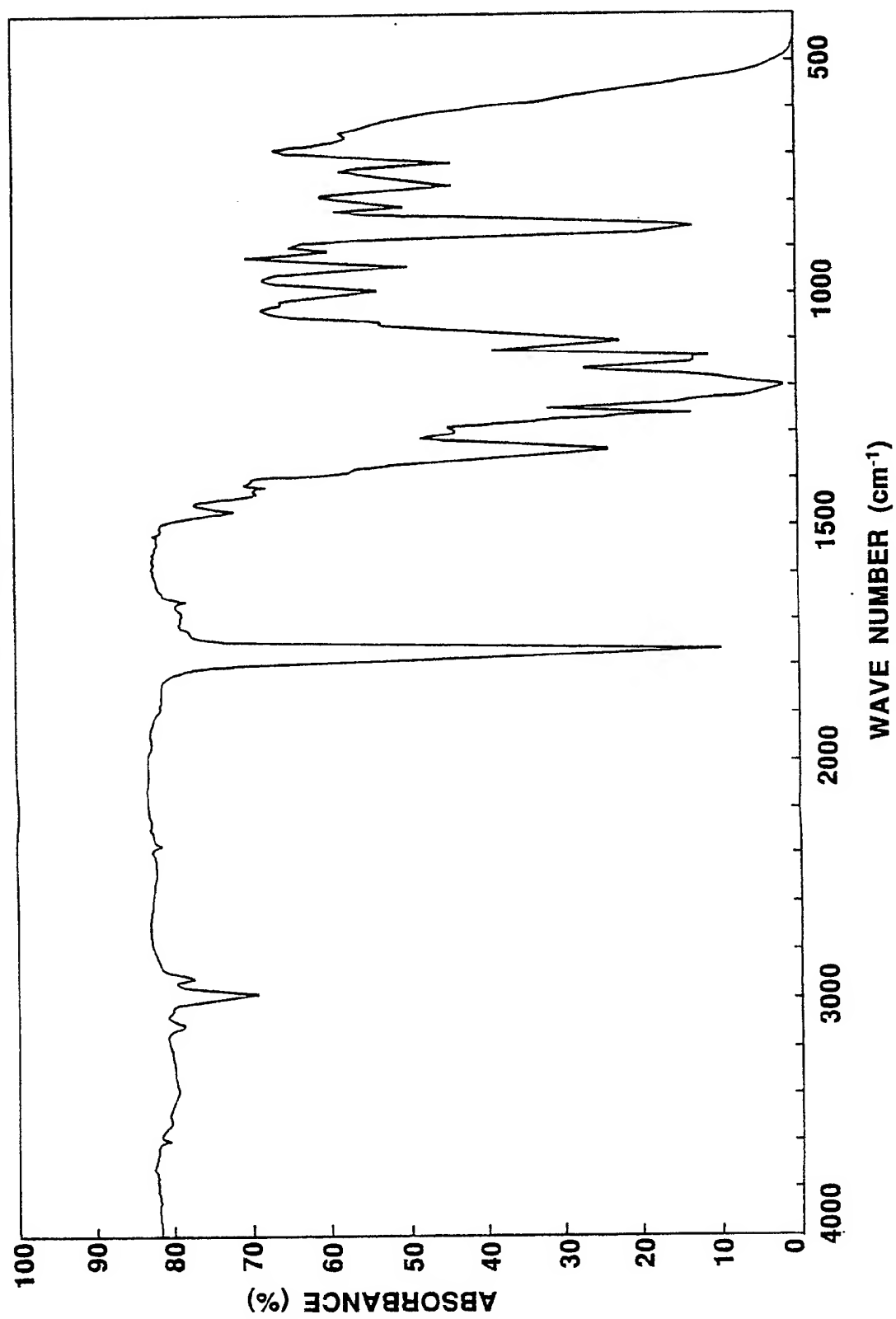
**FIG.1**





**FIG. 3**

**FIG. 4**

**FIG. 5**

**FIG. 6**